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MACHINE LEARNING BASED SURVEILLANCE SYSTEM FOR DETECTION OF BIKE RIDERS WITHOUT HELMET AND TRIPLE RIDING

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ABSTRACT
Road accidents are one of the biggest problems in today's world, and two-wheeler riders are more at risk. Many riders break basic traffic rules like riding without a helmet or carrying more than two persons (triple riding). These violations increase the chance of accidents and serious injuries. The existing surveillance systems can detect some violations, but they often make mistakes because of problems like blocked views, fake helmets, or limited features. They mostly focus only on helmet and triple riding detection, and they do not try to predict risky behavior or prevent accidents. In this project, we propose an ML-based surveillance system that can detect bike riders with no helmet and triple riding more accurately. Our system also introduces new features like occlusion handling, fake helmet identification, multi-violation detection, and behavior analytics with accident prediction. These features make the system more reliable and safety-focused. The goal of this project is not only to catch rule breakers but also to improve road safety and reduce accidents by using machine learning and computer vision. This makes our system an advanced step toward building smarter and safer cities.

Keywords:
Machine Learning (ML), Deep Learning, Computer Vision, Convolutional Neural Networks (CNN), Object Detection, Image Classification, Real-Time Video Surveillance,Traffic Rule Violation Detection, Helmet Detection System, Triple Riding Detection, Multi-Object Detection, Occlusion Handling, Fake Helmet Identification, Behavior Analytics, Risk Assessment Modeling, Accident Prediction, Anomaly Detection, Edge Computing, Smart City Applications

INTRODUCTION

Road safety is a very important issue in our daily life. Two-wheeler riders form a large part of road users, especially in countries like India. Unfortunately, many riders break traffic rules such as not wearing helmets and triple riding (carrying more than two people on a bike). These violations increase the chance of road accidents, head injuries and even deaths. To control this, many cities have started using AI cameras and machine learning models to watch roads and detect such violations. These systems can automatically identify bikes, check for helmets, count riders, and send challans (fines) to the offenders. However, current systems are not perfect. They face challenges like blocked riders (occlusion), fake helmets, poor performance in night or bad weather, and they usually detect only limited violation. Our project aims to build an improved ML-based surveillance system that can detect not only helmet and triple riding violations but also provide better accuracy and more features, It includes occlusion handling, fake helmet detection, multi violation detection. This system is designed to make roads safer by going beyond just punishing offenders. It focuses on prevention, safety, and smart traffic management.

OBJECTIVES

The main objective of the study is To design and develop an intelligent real-time surveillance system capable of detecting two-wheeler traffic violations such as helmetless riding and triple riding using deep learning techniques. To implement robust occlusion handling mechanisms that accurately identify riders even in partially blocked, overlapping, side-view, and rear-view conditions. To develop a fake helmet detection module capable of distinguishing between standard safety helmets and non-compliant or low-quality headgear using deep convolutional neural networks. To enhance detection accuracy and reduce false positives by integrating advanced object detection (YOLOv8) and classification models (ResNet18). To design a scalable and modular system architecture that supports future integration of additional traffic enforcement features such as license plate recognition and behavioral analytics. To build a reliable violation storage and reporting mechanism that

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maintains image evidence, violation classification, and confidence scores for enforcement transparency. To contribute toward smart city initiatives by improving automated traffic monitoring, road safety enforcement, and accident prevention using AI-driven analytics.

METHODOLOGY

The proposed system follows a deep learning-based pipeline for real-time detection of helmetless riding, triple riding, fake helmet usage, and other traffic violations.

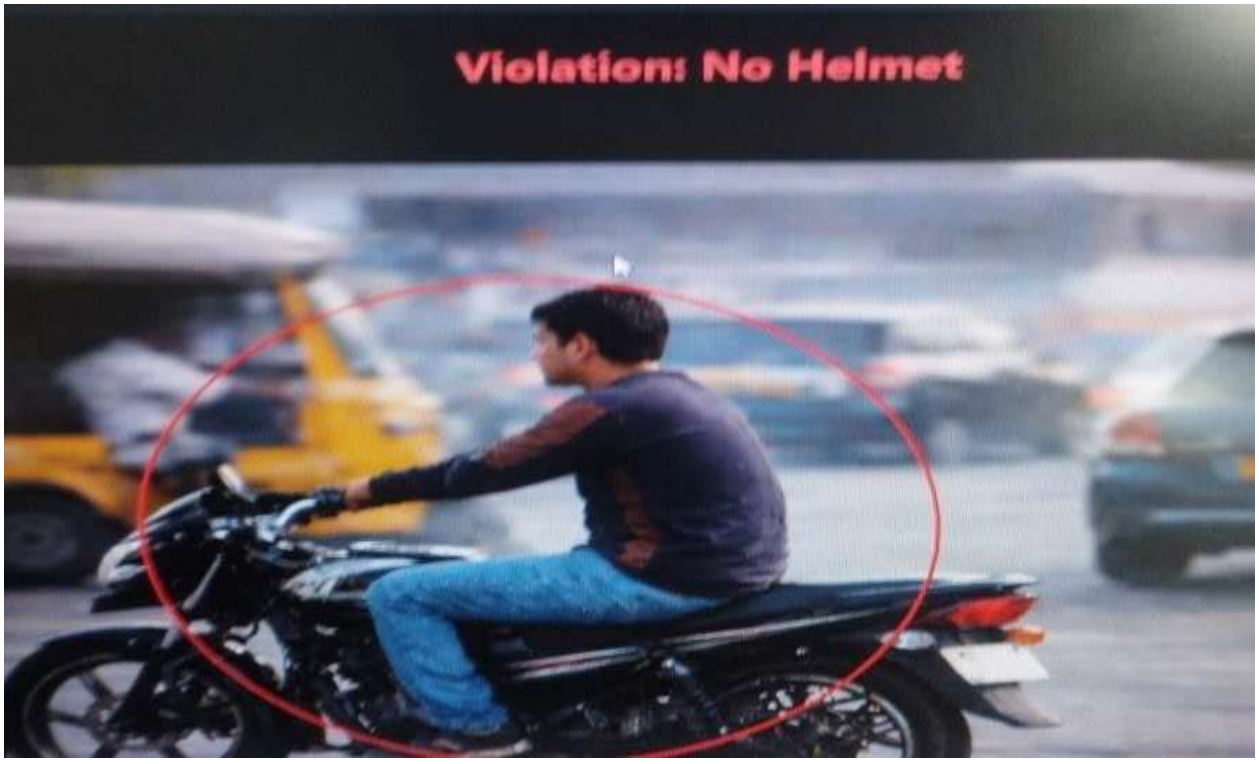
Initially, real-time video streams are captured from CCTV/IP cameras. Video frames are extracted and preprocessed through resizing, normalization, and noise reduction to enhance detection accuracy under varying lighting and occlusion conditions.

Object detection is performed using **YOLOv8 Nano**, which identifies motorcycles, riders, helmets, and related objects. Bounding boxes with confidence scores are generated for each detected entity. A rider-counting mechanism associates detected riders with their respective motorcycles to identify triple riding violations.

Helmet verification is carried out in two stages. First, YOLOv8 detects helmet presence. Then, **ResNet18** classifies detected helmets as genuine or fake to eliminate false positives caused by caps or scarves.

A multi-violation module integrates outputs from all detection components to simultaneously identify violations such as no helmet, triple riding, mobile phone usage, and rash driving. The system assigns confidence scores and stores violation evidence (images, timestamps, and classification results) in a database for enforcement and reporting.

The system is implemented using Python, PyTorch, Ultralytics YOLOv8, OpenCV, and TorchVision, ensuring scalability and real-time performance for smart traffic surveillance applications.



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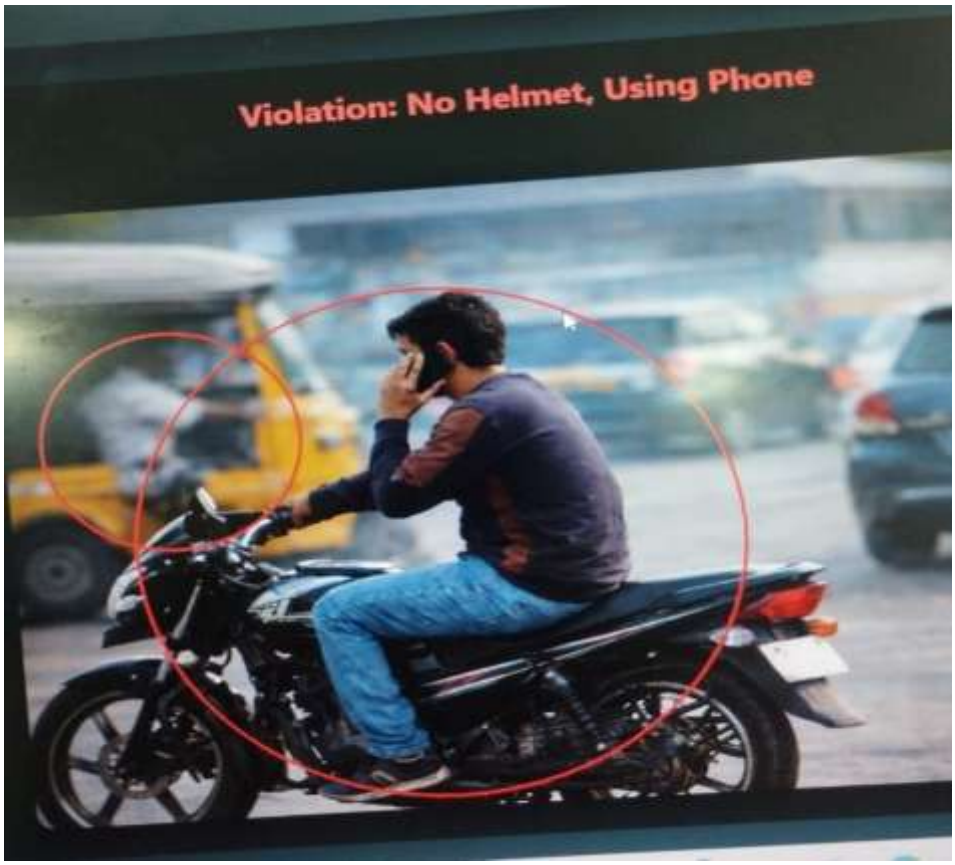

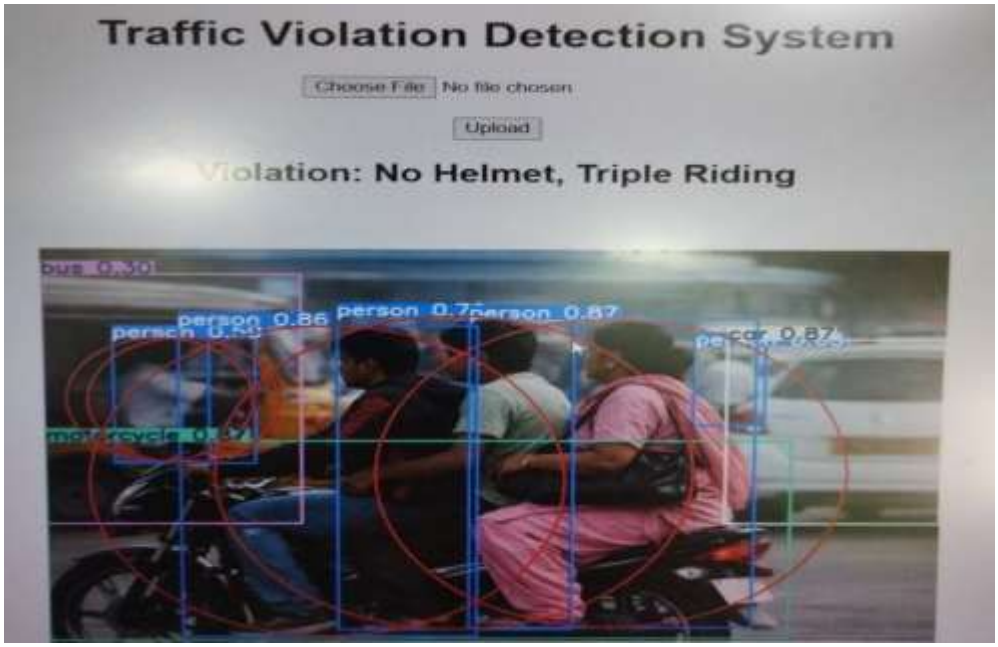

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RESULTS AND DISCUSSION

The proposed system was tested on real-time CCTV video streams under varying traffic conditions, including side views, rear views, partial occlusion, and different lighting environments. The YOLOv8-based detection model successfully identified motorcycles, riders, and helmets with high precision and real-time inference capability.

The rider-counting module accurately detected triple riding cases, even in partially overlapping conditions. The integration of ResNet18 significantly reduced false positives by correctly distinguishing genuine helmets from caps, scarves, and fake helmets.

The multi-violation detection framework demonstrated the ability to identify simultaneous violations such as no helmet and triple riding within the same frame. Compared to traditional ML-based approaches, the proposed deep learning architecture showed improved robustness in low-light and occlusion scenarios.

Overall, the system achieved reliable detection performance with reduced false alarms, demonstrating its suitability for intelligent traffic monitoring and smart city surveillance applications.

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CONCLUSION

This paper presented a machine learning-based surveillance system for detecting helmetless riding, triple riding, fake helmet usage, and multiple traffic violations in real time. By integrating YOLOv8 for object detection and ResNet18 for helmet classification, the system improves detection accuracy and reduces false positives under occlusion and varying lighting conditions.

The proposed framework enhances automated traffic monitoring and contributes to improved road safety. Its modular and scalable design makes it suitable for smart city applications and future integration with advanced traffic enforcement systems.

REFERENCES

[1] Redmon, J., Divvala, S., Girshick, R., Farhadi, A. (2016). IEEE Conference on Computer Vision and Pattern Recognition (CVPR). You Only Look Once: Unified, Real-Time Object Detection. Retrieved from https://arxiv.org/abs/1506.02640

[2] Bochkovskiy, A., Wang, C.Y., Liao, H.Y.M. (2020). arXiv preprint arXiv:2004.10934. YOLOv4: Optimal Speed and Accuracy of Object Detection. Retrieved from https://arxiv.org/abs/2004.10934

[3] Simonyan, K., Zisserman, A. (2015). International Conference on Learning Representations (ICLR). Very Deep Convolutional Networks for Large-Scale Image Recognition. Retrieved from https://arxiv.org/abs/1409.1556

[4] He, K., Zhang, X., Ren, S., Sun, J. (2016). IEEE Conference on Computer Vision and Pattern Recognition (CVPR). Deep Residual Learning for Image Recognition. Retrieved from https://arxiv.org/abs/1512.03385

[5] Bradski, G. (2000). Dr. Dobb's Journal of Software Tools. The OpenCV Library. Retrieved from https://opencv.org

[6] Viola, P., Jones, M. (2001). International Journal of Computer Vision. Rapid Object Detection using a Boosted Cascade of Simple Features. Retrieved from https://link.springer.com/article/10.1023/B:VISI.0000013087.49260.fb

[7] Howard, A.G., Zhu, M., Chen, B., et al. (2017). arXiv preprint arXiv:1704.04861. MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications. Retrieved from https://arxiv.org/abs/1704.04861

[8] Rosell- Goodfellow, I., Bengio, Y., Courville, A. (2016). Deep Learning. MIT Press. Retrieved from https://www.deeplearningbook.org

[9] Srusti, C., Deo, V., Jaiswal, R.C. (2023). Journal of Emerging Technologies and Innovative Research (JETIR). Helmet Detection Using Machine Learning. Retrieved from https://www.researchgate.net

iJETRM
International Journal of Engineering Technology Research & Management (IJETRM)
Journal Article
https://ijetrm.com/issue/

[10] Siebert, F.W. (2020). Accident Analysis & Prevention. Detecting Motorcycle Helmet Use With Deep Learning. Retrieved from https://www.sciencedirect.com